DUAL AIRBAG AIRSPRING

BACKGROUND OF THE INVENTION

[1] The present invention relates to an air spring, and more particularly to an air spring with an inner airbag as a roll off piston.

[2] Air spring assemblies are utilized for a variety of applications. One such application is to cushion the ride of a vehicle. An air spring assembly generally includes a flexible member attached to a piston. The piston advances or retreats into the interior of the flexible member, which changes the internal volume of the assembly. The spring rate depends on the change of internal volume and the effective area of the piston. In addition, the amount of air delivered to the interior of the flexible member is adjustable to vary the preload or ride height.

[3] To vary the spring rate of a conventional air spring, auxiliary air tanks are selectively connected to the flexible member to change the effective volume of the air spring. Disadvantageously, the auxiliary air tanks may present packaging difficulties and are limited by the cross-sectional area of the flow path between the air spring and the auxiliary air tank. Such an arrangement limits the air spring to a two-stage spring rate in which either the auxiliary air tank is connected or disconnected.

[4] Accordingly, it is desirable to provide an air spring assembly, which achieves variable spring rates without auxiliary air tanks.

SUMMARY OF THE INVENTION

[5] The air spring assembly according to the present invention provides a primary airbag mounted around a piston airbag such that the piston airbag provides a rolling surface for the primary airbag. A change in the piston airbag volume changes the effective piston area of the primary airbag. A relatively small change in the effective piston area provides a change in the spring rate of an air spring assembly. By selectively controlling the pressure within the volumes, infinite variation in spring rates are possible without an auxiliary tank and associated actuators. The relatively smaller volume of the piston airbag relative to the

primary airbag permits rapid pressure and volume changes to enable active suspension control.

[6] The present invention therefore provides an air spring assembly which achieves variable spring rates without auxiliary air tanks.

BRIEF DESCRIPTION OF THE DRAWINGS

[7] The various features and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the currently preferred embodiment. The drawings that accompany the detailed description can be briefly described as follows:

[8] Figure 1 is a general side view of an exemplary vehicle suspension system embodiment for use with the present invention;

[9] Figure 2 is a sectional view of an air spring assembly designed according to the present invention;

[10] Figure 3 is a sectional view of an air spring assembly in a first position; and

[11] Figure 4 is a sectional view of an air spring assembly in a second position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[12] Figure 1 illustrates an air suspension system 10 for a vehicle. The system 10 generally includes a bracket 12, a longitudinal member 14, an air spring assembly 16, a damper 18 and an axle assembly 20. The system is fixed to a chassis of the vehicle (shown schematically at 22). It should be understood that although a particular component arrangement is disclosed in the illustrated embodiment, other arrangements will benefit from the instant invention.

[13] Referring to Figure 2, the air spring assembly 16 is illustrated in cross-section. The air spring assembly 16 is defined along an axis A and includes a piston support 26, a piston airbag 28 and a primary airbag 30. An upper mount 32 attached to the primary airbag 30 and a lower mount 31 (illustrated schematically) preferably provide attachment for the air spring assembly 16.

[14] The piston support 26 is preferably a cylindrical member defined about the axis A. The outer piston 26 is preferably attached to the lower mount 31 at welds W or the like. The piston support 26 and the lower mount 31 are relatively rigid components. It should be appreciated that other mount arrangements such as struts and the like will also benefit from the present invention.

[15] The piston airbag 28 is a resilient member and attached to the outer piston 26 through a first band 36 and a second band 38. It should be understood that other attachments will likewise benefit from the present invention. The piston airbag 28 defines a first volume V1 between the bands 36, 38 and a piston airbag outer surface 40 and outer piston 26.

[16] The primary airbag 30 is mounted to the piston air bag 28 through a third band 42 which is directly adjacent the second band 38. That is, the third band 42 and the second band 38 sandwiches the primary airbag 30 therebetween. The primary airbag 30 defines a second volume V2. It should be understood that although two volumes are disclosed in the illustrated embodiment any number of volumes will benefit from the present invention. Moreover, the volumes may be selectively segmented to provide further incremental volume changes.

[17] An air supply 40 (illustrated schematically) communicates air independently into the volumes V1, V2 through a first and a second supply conduit 42, 44 respectively in response to a controller 46. The controller 46 is preferably a suspension controller which provides active suspension control methodology. Ports 48 through the outer piston 26 supply air into the first volume V1. It should be understood that various air supplies will benefit from the present invention and that any air supply system which independently provides air pressure into the volumes V1, V2 will benefit from the present invention.

[18] The piston airbag 28 operates as a rolloff piston surface for the primary airbag 30. That is, the primary airbag provides a rolling lobe over a piston of a variable diameter. That is, the primary airbag rolls along the outer surface 49 of the piston airbag 28. By changing the volume V1 or pressure P1 within the piston airbag 28 the outer diameter of the piston airbag 28 changes. A change in the piston airbag 28 volume V1 thereby changes the effective piston area of the primary air spring 30. It is also understood that the primary airbag 30 will exert a pressure P2 against the piston airbag 28, tending to reduce the outer

diameter 49 until an equilibrium diameter is reached. Therefore a change in pressure P1 will change the radial spring rate of the piston airbag 28 and change the equilibrium diameter also effecting the primary airbag 28 spring rate.

[19] Referring to Figure 3, increasing the air pressure within the volume V1 increases the diameter of the piston airbag 28 to obtain a greater spring rate and ride height. That is, the increase in diameter of the piston airbag 28 results in an extension of the airbag assembly 16 as volume V1 effectively provides a larger rolloff piston. The opposite results are obtained when the pressure within the piston airbag 28 is reduced as volume V1 respectively decreases (Figure 4).

[20] A relatively small change in volume V1 provides a change in the spring rate of the primary air spring 30 as the diameter of the rolloff surface is selectively modified. A change in the pressure within the volume V1 couples a change in spring rate with a change in ride height when the pressure within volume V2 is maintained. The compression and rebound rates may alternatively be decoupled by simultaneously changing the volume of both V1 and V2.

[21] By selectively controlling the pressure within volumes V1 and V2, infinite variation in spring rates are provided without an auxiliary tank and associated actuators. The relatively smaller volume of volume V1 relative to volume V2 permits rapid pressure and volume changes which enables active suspension control.

[22] Although particular step sequences are shown, described, and claimed, it should be understood that steps may be performed in any order, separated or combined unless otherwise indicated and will still benefit from the present invention.

[23] The foregoing description is exemplary rather than defined by the limitations within. Many modifications and variations of the present invention are possible in light of the above teachings. The preferred embodiments of this invention have been disclosed, however, one of ordinary skill in the art would recognize that certain modifications would come within the scope of this invention. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described. For that reason the following claims should be studied to determine the true scope and content of this invention.